Is there a Pulsar in Supernova 1987 A?

A recent announcement of the discovery of a pulsar in Supernova 1987 A in the Large Magellanic Cloud has excited the world-wide astronomical community. New observations at the La Silla Observatory by a group of European astronomers[1] from the Max Planck Institute for Extraterrestrial Physics and the European Southern Observatory, however, do not confirm the reality of this object. More observations are now needed to settle this important question.

Searching for the Pulsar in Supernova 1987 A

Since the explosion of the now famous supernova in the Large Magellanic Cloud on February 23, 1987, astronomers have been eagerly waiting for the emergence of a newborn *pulsar.* Current theories predict that the explosion of a heavy star as a supernova will result in most of its mass being blown out into surrounding space, but also that some of it will be compressed into an extremely dense and rapidly rotating *neutron star* at the centre. Such an object would later manifest its presence in the supernova by the emission of regular light pulses (hence the name "pulsar"). Neutron stars measure no more than 10–15 kilometres across, but they weigh as much as our Sun which is about 100,000 times as large.

Of half a dozen pulsars known in supernova remnants, the most famous are those in the Crab Nebula and the Vela Nebula. The detection of a pulsar inside SN 1987 A, the first naked-eye supernova in nearly four centuries, would provide the definitive confirmation of the creation of pulsars in supernova explosions. Extensive searches for such a pulsar have therefore been made at some southern observatories since the explosion was first recorded, almost exactly two years ago. This is done by observing the supernova light with a "rapid" photometer, capable of measuring the light intensity many times each second. A pulsar would reveal itself by the presence of brief "flashes" of extra light, regularly spaced in time.

Immediately after the explosion, the dense cloud around the supernova did not allow a look at its centre, but as the clouds become thinner, light from the new pulsar should eventually become visible. Many astronomers have been waiting for this exciting moment.

First Detection?

On 8 February 1989, a group of American astronomers[2] announced the discovery of a very fast pulsar in SN 1987 A, flashing no less than 1969 times per second. This is referred to as 1969 cycles/second and supposedly corresponds to the number of rotations per second by the pulsar. No other pulsar has ever been found to rotate this fast. These observations were made on January 18, 1989 at the Cerro Tololo Interamerican Observatory, situated about 100 km south of La Silla. Surprisingly, the American group did not see any pulsations when the observations were continued 12 days later with another telescope.

At the European Southern Observatory, the light of the supernova has been monitored with a special, rapid photometer at the 3.6-m telescope at regular intervals during the past year. The intensity of the supernova light was measured 1000 times per second, a rate which was determined from theoretical considerations about how fast the predicted pulsar in SN 1987 A might rotate. However, it is too slow to show variations at the rate observed at Tololo.

New Observations Fail to Provide Confirmation

In order to confirm the presence of a pulsar with the higher pulsation rate, the ESO instrument was modified immediately after the announcement by the American group, so that it can now measure the supernova light up to 10,000 times per second. On February 14 and 15, observations were performed at the 3.6-m telescope during a total of 8 hours. The data tapes were rushed to the ESO Headquarters in Garching near Munich. The detailed results of a careful analysis at the Max Planck Institute for Extraterrestrial Physics have now been published on IAU Circular 4743 (24 February 1989).

The European team finds that no pulsating signal is present in the ESO data near 1969 cycles/second, to a limit of 1/4000th of the intensity of the supernova light. Nor is there any obvious signal at any other frequency in the interval from 1 to 5000 cycles/sec. These observations therefore do not provide confirmation of the presence of a pulsar.

If there is a pulsar in SN 1987 A, then the absence of observed pulsations in the measurements obtained after January 18, both by the American and the European groups, possibly indicate that the pulsar is being intermittently obscured by dust clouds around the supernova.

Further observations will therefore be needed to definitively demonstrate the reality of a pulsar in Supernova 1987 A.

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[1] The group consists of Hakki Ögelman, Günther Hasinger and Wolfgang Pietsch (Max-Planck-Institut für Extraterrestrische Physik, Garching bei München, F. R. Germany), Christian Gouiffes, Jorge Melnick, Thomas Augusteijn, Flavio Gutierrez, Preben Grosbøl and Christian Santini (ESO) and Holger Pedersen (formerly ESO, now Nordic Optical Telescope Scientific Association).

[2] This group is headed by John Middleditch, Los Alamos National Laboratory; the announcement was made on Circular 4735 of the International Astronomical Union (IAU).

Squeezing the Most from the CES

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Introduction

In the *Messenger* No. 51 (p. 12–15), an attempt to use the CES for radioactive chronometry of the Galaxy was described. Two instrumental aspects of the observations were noted as being not yet under adequate control: (i) The determination in detail of the instrumental profile, the wings of which cannot be determined well, except at laser line wavelengths, and the shape of which is found to depend on the often variable focus across the array detector format, and at least sometimes on the signal level in the detector used. (ii) The markedly asymmetrical distribution of the noise from the Reticon detector (caused by energetic particle detections) for low flux levels and integrations of an hour and longer. Treatment of the data in an optimum way is problematical due to